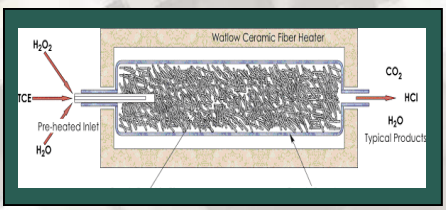
Hydrothermal Oxidation in Support of Pit Manufacturing Operations

Nuclear Materials Technology Division

Hydrothermal processes have many desirable attributes for the treatment of radioactive aqueous and organic waste streams. High destruction and removal efficiencies of organics using hydrothermal oxidation have been reported under mild conditions for a broad range of chemical and metabolic wastes, including some difficult to treat wastes such as chlorinated and aromatic hydrocarbons. The rapid rates of reaction allow for compact process units that can fit into existing nuclear facilities without extensive or expensive facility modifications. Additionally, the effluents from the process can be contained and sampled before they are released to the environment. This combination of features has produced positive responses from the general public to the implementation of the technology to the treatment of radioactive wastes.

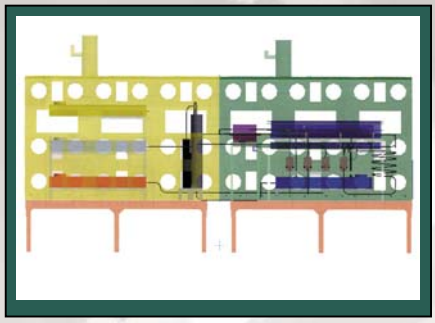
Full-scale reactor unit in the ceramic heater (lower half). The quartz heat exchangers are also shown.

For treatment, the waste is mixed with water and fed through a chemical reactor at elevated temperatures and pre-determined pressures to effect desired chemical transformations and separations. The reactions are carried out entirely in an enclosed vessel and in dilute concentrations so that the water absorbs the heat of reaction and the temperature can be maintained at any desired level. At Los Alamos, continuous flow reactors, ranging in capacity from 0.01 to 1.0 kg/minute, are used to determine kinetics and products of reactions. The aqueous solutions studied thus far contain a variety of organic and inorganic components.



Ambient Pressure Hydrothermal Ractor

Previous work in the Los Alamos National Laboratory's Plutonium Facility (PF-4) demonstrated the success of hydrothermal processes to treat radioactive halogenated organic wastes. A small scale development system was operated in PF-4 at 540°C and 46 MPa. The oxidant, hydrogen peroxide (30 wt. %), is mixed with the waste and fed into the reactor. The mixing and the oxidation process rapidly heat the waste/peroxide mixture in the top portion of the reactor. The oxidation reactions are rapid, and over 99.9% of the organic compounds are converted to carbon dioxide and other mineral products within 60 seconds. We demonstrated over 99.9% destruction of a suite of combustible materials in PF-4 using this design. Most of the actinides in the waste are converted to insoluble solids that can be removed by simple filtration. In some cases, the levels of actinides in the liquid effluent can be reduced by nearly a factor of 1000. For most of the wastes tested, the actinide concentration in the effluents is near or below U.S. regulatory levels required for discharge into industrial waste lines following filtration.



Layout of Equipment in Glove box

For the destruction of TCE (trichloroethylene), the system was modified to operate at ambient pressure to overcome corrosion issues that occurs from generation of HCl in the effluent. We have fabricated and demonstrated an pilot scale (1.5 liters / day) ambient pressure, high temperature process for destruction of concentrated halogenated organic solutions achieving more than a 99.99% removal of the organic constituent. The effluents are acidic, yet can be neutralized in a post processing step. The processing and kinetic data were used to design a system for the treatment of 20 liter of TCE per month, the anticipated generation rate. The final fabrication and testing of a full scale 20 liter / month treatment unit for pit manufacturing needs was accomplished in the past year.

Contacts: Dennis Padilla, Laura Worl, NMT-11 (505) 665-7149